Dissipation and Persistence of Thiodicarb in Cotton

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Abstract

Field study was carried out to investigate persistence and dissipation kinetics of thiodicarb (Larvin 75 WP) applied at the time of flower initiation stage of cotton crop (H-1117) @ 500 (T1) and 1000 g a.i.ha-1 (T2) during kharif season. The dissipation was 100% in soil at both the doses after 35 days of application following a first order kinetics. The half life value was observed to be 7.27 days in T1 and 7.81 days in T2, respectively.

Keywords

Thiodicarb; Half- Life;, Dissipation; First Order Kinetic; Residue

Introduction

Cotton, 'The King of Fibers and a crop of prosperity' having a great impact on men and matter, is an industrial commodity worldwide importance. It is one of the most important cash crops of India, grown over an area of about 88.2 lakh hectare, with a production of 242.50 lakh bales and productivity of 467 kg ha^{-1} (Anonymous, 2007). It is grown under diverse agroecological conditions in North, Central and South zones. Unfortunately, cotton is damaged by multitude of insectpests and diseases that pose a serious threat in arresting high cotton production in India. Crop losses in cotton have been reported due to several pests chiefly including *Earias vittella* (30- 40%), *Pectinophora gossypiella* (20-95%) [Panwar, 1995] and *Helicoverpa armigera* (20-80%) [Monga and Jeyakumar, 2002]. Several potent pesticides have been recommended to eliminate these pests on this crop which consumes around 50% of pesticides in India (Singh *et al.*, 2004) and accounts for 40% of the total production cost and ranks first in terms of pesticide consumption (Dudani and Sengupta, 1992). But the pesticide use pattern in the present day situations has led to resistance build up by pests and pesticide residues, which demands newer and safer pesticides with different modes of action.

Thiodicarb, [3,7,9,13-tetramethyl-5,11-dioxa-2,8,14-trithia-4,7,9,12-tetraazapenta deca-3,12- diene-6,10-dione] is non systemic oxime carbamate which acts as insecticide and ovicide with both oral and contact activities against major *Lepidoptera*, *Coleoptera*, *Diptera* and *Hemiptera* pests on cotton, maize, fruits, soybean and vegetables (Fig. 1). It is a neurotoxic compound that acts by inhibiting acetyl cholinesterase activity. Thiodicarb is commonly used as seed treatment, due to its translocation through the plant (Tomlin, 2003)

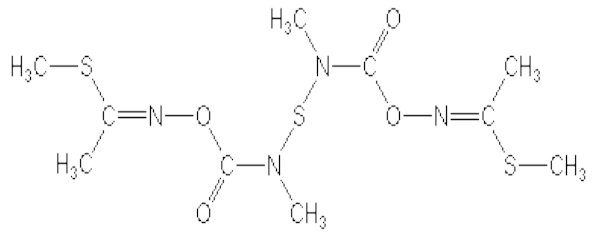

FIG. 1 STRUCTURE OF THIODICARB

As very scanty work has been carried out to know the behaviour of thiodicarb on cotton under Indian conditions, so the present studies were carried out to generate information about persistence and degradation behaviour of thiodicarb on soil, cotton seed and lint.

Material and Methods

A field experiment was conducted on sandy loam soil (EC 2 dSm^{-1}; K_c 10.08, P_2O_5 15 kg ha^{-1}) having pH 7.6 and organic carbon 0.67% at Research Farm of the Department of Plant Breeding, CCS HAU, Hisar using randomized block design (RBD) with a plot size of 25 m^2 on which cotton (*Gossypium hirsutum*) variety H-

1117 was raised during *Kharif* season. Thiodicarb (Larvin 75 WP) was applied in the field at the time of flower initiation stage at two different doses. The treatment T_1 was 500 g a.i.ha^{-1} and T_2 consisted of 1000 g a.i.ha^{-1} and a control where no pesticide was applied. Samples of soil under the cover of cotton crop were collected periodically from top 15 cm of soil profile on 0 (1h after treatment), 7, 14, 21, 28, 35 and 42 days after spray and cotton lint and seeds were collected at the time of harvest. The samples were processed as per method of Anonymous (1978).

Well ground, sieved and representative soil sample (20 g) was shaken vigorously on mechanical shaker for 1.5 hour after adding 100 ml solution of 1:1v/v acetone: water. The extract was then filtered through Whatman's paper no. 1and transferred to separatory funnel after that diluted with 10% sodium chloride solution and partitioned thrice with dichloromethane (75, 50,25ml) by vigorous shaking. The extract was concentrated to near dryness and the volume made up to 2 ml with n-hexane and_analyzed by GC.

To the representative 5 g cotton lint, 10 g each cotton seed and seed cake, 200 ml acetonitrile was added and extracted on Soxhlet apparatus for 8 h. The extract was then filtered, transferred in separatory funnel and diluted it with 10% sodium chloride solution. The extract was partitioned twice with hexane (100,100 ml) followed by partitioning twice with dichloromethane (100,100 ml) by vigrous shaking. The organic phases were combined and then concentrated to about 5 ml on a rotary vacuum evaporator at 50-55°C. For clean–up, glass column (60 cmx22 mm i.d) was packed compactly with silica gel in between two layers of anhydrous sodium sulphate. The column was prewetted with hexane firstly and then the concentrated extract was loaded in the column which was eluted with a solution of dichloromethane: acetone(1:1v/v). The cleaned extract was evaporated to dryness and finally dissolved in 2 ml n-hexane for analysis by GC.

Residues of thiodicarb were determined on Shimadzu 2010 equipped nitrogen phosphorous detector and HP-1 capillary column (30 m x 0.32 mm i.d. x 0.25 µm film thickness). Other GC parameters were as follows: Temperature (°C): Oven: 100 (1 min) →10°min^{-1} →200 (0 min) →20^{0}° min^{-1} →260^{0}(3 min). Injection port: 250; detector: 275. Carrier gas (N_2) flow was 1.8 ml min^{-1}. Retention time (Rt) for thiodicarb was 1.655 min.

Result and Discussion

TABLE 1 RESIDUES (MGKG-1) OF THIODICARB IN SOIL

Days after treatment	Residue (mg kg^{-1})			
	T_1 (500g a.i. ha^{-1})		T_2 (1000g a.i. ha^{-1})	
	Average Residues	% Dissipation	Average Residues	%Dissipation
0	0.015	-	0.027	-
7	0.007	53.33	0.013	51.85
14	0.004	73.33	0.008	70.37
21	0.002	86.66	0.004	85.18
28	BDL	100	BDL	100
35	-	-	-	-
42	-	-	-	-
Harvest	-	-	-	
Rate constant k (days^{-1}) = 0.09532 Correlation Coefficient r = -0.9991 Regression Equation = 1.1640-0.04137x $t_{1/2}$ = 7.27 d			Rate constant k (days^{-1}) = 0.08873 Correlation Coefficient r = -0.9972 Regression Equation = 1.4173-0.03855x $t_{1/2}$ = 7.81 d	

C.D. (P=0.05) for days=0.002, for dose=0.001, for days x for dose = 0.003 ; BDL: 0.002 mg kg^{-1}

Average recoveries of thiodicarb from samples of soil fortified at 0.25 and 0.50 mg kg^{-1} levels were 96.13 and 93.14 per cent, respectively whereas those from cotton lint fortified at 0.50 and 1.0 mg kg^{-1} levels were 85.63 and 82.11 per cent, respectively and those from cotton seed oil fortified at 0.50 and 1.0 mg kg^{-1} levels were 83.65 and 79.01 per cent, respectively while that of seeds were 82.41 and 80.11, respectively.

As evident from Table 1, thiodicarb when applied @ 500 g a.i. ha^{-1}(T_1) had average initial deposits of 0.015 mg kg^{-1}on 0 day (1 h after treatment) which dissipated to 98.66 per cent leaving 0.0002 mg kg^{-1} residues after 28 days of the treatment. While at T_2 (1000 g a.i. ha^{-1}), the initial residues of 0.027 mg kg^{-1}on 0 (1 h after treatment) day dissipated to 0.0006 mg kg^{-1} residues in the soil after 28 days of the treatment showing percent dissipation of 97.77. The residues decreased significantly with increase of time duration, were below detectable level at both T_1 and T_2 after 35 days

of the spray showing that the residues were dissipated completely (100%) at the applied doses. The persistence toxicity of thiodicarb was found to be 587.9 hours i.e. 24.49 days when used at recommended dose by Dhawan et al (2009). Brevault et al (2009) used thiodicarb @ 750g a.i. ha^{-1} in cotton field and reported that the insecticide persisted for 27.0 days in the absence of rain but rainfall had negative effect on persistence of thiodicarb which got reduced to 17.3 days. The dissipation of thiodicarb residues in soil followed first order kinetics (Fig. 2). Half-life of thiodicarb applied @ 500 g a.i. ha^{-1}(T_1) was found to be 7.27 days and 7.81 days when applied @ 1000 g a.i. ha^{-1}(T_2). In the studies carried

TABLE 2 RESIDUES (MG KG-1)OF THIODICARB IN COTTON LINT, SEED, OIL AND CAKE

Commodity	T_1 (500 g a.i.ha^{-1})	T_2 (1000 g a.i. ha^{-1})
Cotton Lint	0.226	0.451
Cotton seed	0.169	0.227
Seed oil	0.013	0.020
Seed Cake	BDL	0.010

BDL: Below detectable Level; MRL: 0.5mg/kg for cotton seed; 0.02mg/kg for seed oil

out to know the movement of thiodicarb in surface soils by Jones et al (1989), the half life of the insecticide was found to be few hours only. Statistically analyzed data showed that the interaction between days and treatment was found to be significant with the value of 0.003 and critical difference (p= 0.005) for treatments was found to be 0.001 while for days it was 0.002. The residues from 21 days onward after treatment were at par. Higher dose showed significantly more residues as compared to lower dose (CD=0.002; p≤ 0.05). As evident from Table 2, residues of thiodicarb in lint at harvest were detected to a level of 0.226 and 0.451 mg kg^{-1}in T_1 and T_2 treatments, respectively. Several factors affect insecticide persistence on crop produce, but the most important is prevailing weather conditions during and after application (Mulrooney and Elmore, 2000). Due to non- availability of MRL values in lint, safety level of thiodicarb could not be assessed. In cotton seed, the residues at harvest were below MRL value of 0.02 mg kg^{-1} whereas in cottonseed oil, residues of thiodicarb at harvest remained below MRL value of 0.02 mg kg^{-1} in both treatments. In seed cake at harvest, no residues were detected in T_1 treatment while residues to a level of 0.010 mg kg^{-1} were detected in T_2 treatment.

Conclusion

The residues of thiodicarb were below detectable level in soil at the time of harvest thus indicating 100 percent dissipation. Therefore, thiodicarb at the tested doses i.e. 500 g a.i. ha^{-1} and 1000 g a.i. ha^{-1} in soil system can be considered safe from the point view of hazards due to its residues.

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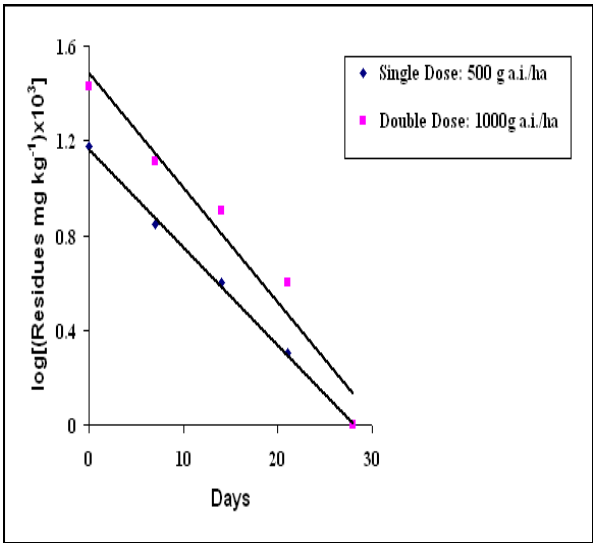

FIG 2 DISSIPATION KINETICS OF THIODICARBRESIDUES IN SOIL

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